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Hubble's Scientific Successor, an interview with Dr. Amber Straughn

Sara: Welcome to Blueshift, brought to you from NASA's Goddard Space Flight Center. I'm Sara Mitchell.

You may know the James Webb Space Telescope is the scientific successor to the Hubble, and it's a big deal here at Goddard because much of the telescope is being built and assembled here. We interviewed Dr. Amber Straughn, a scientist here in the Astrophysics Science Division who splits her time between education and outreach, the Webb telescope, and the study of galaxies. She talked about her research and what has her excited about the future of astrophysics with the Webb.

Maggie: Thanks for being with us. Why don't you tell us a little about who you are and what you do at Goddard.

Amber: Sure. My name's Amber Straughn. I'm an Astrophysicist in the Observational Cosmology Laboratory at Goddard, and my primary job is to study the universe using data from Hubble. So that's a very basic explanation of what I do. I also have responsibilities on the James Webb Space Telescope Project, and I also work with the Astrophysics Education Public Outreach Team.

Maggie: The James Webb Space Telescope has been called the successor to Hubble. What you can tell us about it?

Amber: Well, it's definitely the scientific successor to Hubble so we're building this telescope to answer the big questions that Hubble just can't answer. Hubble is awesome; everybody loves Hubble, and we all know that Hubble has revolutionized our understanding of the universe. But there are certain ways that we really have pushed Hubble to its limits, and so we're developing and building the James Webb Telescope to answer those really big science questions that Hubble can't quite answer.

Maggie: How will Webb be different from Hubble?

Amber: Webb is different from Hubble in a few key ways. The first big difference is the size. Hubble's about the size of a school bus; Webb is more the size of a jet plane. So it has a sun shield that's about as big as a tennis court, and it's several stories high. Having this big, big telescope is really going to help us to learn more about the universe.

The second key difference is the type of light that Webb will see. Hubble is primarily an optical telescope – it sees the universe in visible light that your eyes see. Webb is gonna be an infrared

telescope, so it will see the universe in light that's a little bit more red than what your eyes can detect. And that's gonna allow us to see some really unique things about the universe.

And the third key difference between Hubble and Webb is its location in space. Hubble orbits the earth a few hundred miles up. Webb is going to be much deeper in space – about a million miles away. That's about four times further away than the moon. So it'll be in a different place in space, so it can get very, very cold in order to detect faint infrared radiation from a distant universe.

Maggie: So I saw a discussion on Facebook this morning about what the difference was between what WMAP and COBE saw of the early universe and what Webb's going to see. Can you talk a little bit about the difference between those missions?

Amber: The key thing that Webb is going to do differently is… Webb will be able to see the actual physical galaxies that existed right after the Big Bang. So the very first galaxies that popped into existence after the Big Bang, Webb will be able to see. In essence COBE and WMAP kind of took baby pictures of the universe. Webb is going to be able to see galaxies after they've actually formed, so a lot of the images we get back from Webb will be similar to what you're used to seeing from Hubble or Spitzer – they'll be actual pictures of galaxies, and then of course of other things that too that we'll learn from Webb.

Maggie: What else will Webb do differently than Hubble as far as new information about galaxies? What will we learn about galaxies from Webb?

Amber: One of the key things that Webb is designed to look at is again to detect to those very first galaxies that existed. We know that more distant galaxies are redshifted, which I believe you talked about on your blog before, and Hubble, because it only sees out so far in the red of the electromagnetic spectrum, can only see galaxies that are so far back. So we're really missing those very first galaxies that were formed after the Big Bang. We'll be able with Webb to see those very, very first galaxies because the light's been shifted so far into the red that it's all the way into the infrared part of the electromagnetic spectrum.

Maggie: How are the galaxies that Webb will observe different from the sort of classic spiral galaxies that we're familiar with today like the Andromeda galaxy? Do they look different when they're much younger?

Amber: Right, so that's another one of the key themes, one of the big science questions we hope to address with Webb is the assembly of galaxies: how galaxies build up over time. So you're right. We do see a completely different picture when it comes to galaxies when we look at distant galaxies. Many of the galaxies in the present day universe, as you said, are very organized, have lots of spiral structure, they're very big, a lot of them. The galaxies that we see in the distant universe are a completely different picture. They're small and clumpy, a lot of them, kind of train wreck type objects… and so this question of how we develop structure over time is still a big open question in astronomy and we expect to learn a lot about that process

from Webb.

Maggie: You mentioned earlier that your research involves galaxies. What in particular?

Amber: My particular area of research involves how stars form in distant galaxies. So galaxies that redshift about one or two, so kind of at the peak epoch of when galaxies were really forming stars.

Some of my latest research has been using Hubble's new Wide Field Camera 3, and that has some infrared capability also, so with this instrument we're getting a little bit of a hint of what JWST might see. So it goes just a little bit into the near infrared. Webb will go much further and extend all the way into the mid-infrared. But with this new instrument we've been able to study details of how stars are forming at this really important epoch, and so my research involves looking at that – looking at distant galaxies and learning how many stars they're forming, and how fast they're forming, what the masses of these stars are… And so it's really exciting, fun research. I get to look at Hubble data, spectroscopic data, and imaging data from Hubble to learn about what's going on in these galaxies.

Maggie: Do you have an idea what you'll do with Webb data when we get it and how that would add to the research you've already done?

Amber: Sure. One of the key things that Webb is going to be able to do, again because it's going to see redder in the spectrum, it's going to essentially going to shift all of this great work we've been able to do with Hubble further into the red, which means higher redshift, more distant galaxies. We've kind of pushed Hubble to its limits in a lot of these ways because we just can't see more distant galaxies in great detail. And Webb is going to allow us to see those more distant galaxies in very great detail. It will essentially bring into focus a lot of the things that Hubble can't see yet.

Maggie: Are you hoping to see that star formation in these earlier galaxies than the ones you're looking at now?

Amber: Definitely. Yeah, so that's one of the key things and it kind of goes along in this theme of galaxy assembly because one of the parallel things that happen when galaxies assemble or when they merge together, for example, is enhance star formation and also black hole growth. So when galaxies merge together, there's a lot of cool interesting physics that goes on and the great new spectroscopic capabilities we're gonna have with Webb will allow us to see a lot more of that in detail at higher redshift.

Maggie: Other than galaxies and learning how they assemble and form, what else will Webb study?

Amber: In addition to finding the very first galaxies and learning how galaxies evolve and change over long periods of time, Webb has two other main science themes that we hope to

learn a lot about and the kind of number three on the list is we want to learn how stars are formed, so obviously star formation is a very fundamental process in the universe. And there's a lot about it that we don't know, and one of the main reasons for that is that stars are born inside big clouds of dust, and it's hard to see through dust. In fact, it's impossible to see through dust in optical light. So you see these beautiful pictures from Hubble, like the Pillars of Creation, the Eagle Nebula, and those are beautiful but you can't see inside them because we're looking at it in optical light. Infrared light can pierce right through the dust and see the newborn stars inside so that's one of the key things we hope to study with Webb is star formation because we'll be able to see it much better in infrared light.

And then the fourth big science theme is that we hope to learn more about exoplanets, so planets orbiting other stars outside of our own solar system. This is a relatively new area of astronomy research and it's really exciting. Right now we know that thousands of these exoplanet candidates exist. We know that they're out there; Kepler's found a lot of them. We know they're there, but we don't know a lot about them. Webb is going to be able to study some of these exoplanet candidates in detail. For example, Webb would have the capability to detect water vapor in some of these exoplanet candidates, which is really exciting.

Maggie: Is there anything else that you're really excited about James Webb and what it will bring to astronomy?

Amber: One of the really cool things I think about these huge NASA missions, or any NASA mission, are the things that we undoubtedly will learn that we aren't even expecting. So we have all of these very detailed questions that we set out to answer. That's great and that's how we progress in science, is by getting good questions and building missions to answer them. But what always happens with these kinds of missions is we learn things that we didn't expect, and so that's one of the best things I think about working on a project like this is thinking about all those surprises that are out there waiting to be discovered.

Sara: For more about the James Webb Space Telescope and other science coming out of NASA's Astrophysics missions, visit our website at universe.nasa.gov/blueshift

And if you'd like to learn more about galaxies, guest blogger Koji Mukai recently wrote about the definition of a galaxy. You can also find that on our website.

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